Genetic Parameters of Various Backfat Measurements of the Hungarian Large White Pig evaluated Within and Across Sexes

László CSATÓ [1]
István NAGY [1*]
János FARKAS [2]
László RADNÓCZI [3]
Zsuzsanna VÍGH [1]

SUMMARY

Genetic parameters for various backfat measurements (BF1FT, Backfat shoulder measured at the field test; BF2FT, Backfat mid-back measured at the field test; BF3FT, Backfat loin measured at the field test; BF1ST, Backfat shoulder measured at the station test; BF2ST, Backfat mid-back measured at the station test; BF3ST, Backfat loin measured at the station test) were estimated. The analysis was based on the national database of the field and station tests, using various types of animal models in Hungarian Large White (LW), breed between May 1996 and February 2001 within and across sexes (females, males, castrates). Heritability for BFFT traits ranged between 0.15-0.35, but higher estimates were observed in field traits (0.41-0.75). Genetic correlations were generally positive among all fat depth measurements but station traits showed stronger genetic correlations (0.76-0.88) than field traits (0.24-0.67).The genetic correlation estimates between field and station traits ranged between 0.09-0.40.

KEY WORDS

genotype, sex, environment interaction, pig.

[1] University of Kaposvár, Department of Pig Breeding
Guba Sándor str. 40, Kaposvár, Hungary, H-7400;
[2] University of Kaposvár, Department of Mathematics and Informatics
Guba Sándor str. 40, Kaposvár, Hungary, H-7400;
[3] National Institute for Agricultural Quality Control,
Keleti Károly str. 24, Budapest, Hungary H-1024.

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INTRODUCTION

In Hungary, selection in pig breeding is based on data from both field (FT) and station tests (ST). In the field test backfat shoulder, backfat mid-back, backfat loin, thickness measurements are taken on live animals using ultrasound scanning. In the station tests, after the test animals are slaughtered fat thickness values are measured on the carcasses at the same body regions as in the field tests. From a genetic viewpoint a certain trait measured in two environments (in this case field and station tests) can be regarded as two separate traits. Genetic correlation coefficient among the two traits provides the genotype environment interaction (Falconer, 1952). Genetic correlation close to unity (higher than 0.8) would mean the same ranking of genotypes in both environments. On the other hand a low genetic correlation for a certain trait measured in the field and station tests would mean that the ranking of boars based on own performance test (field test) and progeny test (station test) would differ significantly.

In the previous work Csató et al. 2002 tested existence of the genetic environment interaction by estimating genetic correlation coefficients among the same backfat measurements (shoulder, mid-back, loin) in the field and station tests respectively. However, at least to our best understanding there our no recent estimates available on pigs within and across the sexes (i.e. females, males in the field test and females, castrates in the station test) therefore the objective of this analysis was to inspect the existence of genotype environment interactions within the various sexes and sex environment interactions using the Hungarian Large White population.

MATERIALS AND METHODS

The genetic analysis was conducted on the data collected by the National Institute for Agricultural Quality Control of Hungary between May 1996 and February 2001, using field and station test datas of Hungarian Large White (LW) breed.

As reported by Groeneveld et al. (1996) in the field test the following three ultrasonic (Sonomark 100) backfat measurements on the middle of the chordal spine are taken from boars and gilts weighing between 80 and 110kg-: shoulder: BF1FT, mid-back: BF2FT, loin: BF3FT. Body weights were recorded at the same time with an accuracy of 1kg. All healthy animals in a litter are tested on the farm except for those sent to the station. Gilts are kept in groups up to 25 while boars are raised in smaller groups up to 15 on an ad libitum feeding regime.

In the station test from one litter a castrate and a female are sent to the station between the age of 65-77 days. Body weight of the animals at the age of 65 days should be at least 17kg but not greater than 32kg. After some preliminary adaptation period the test begins at the age of 80 days (body weight at this age is at least 23kg) and ends with reaching the final weight of 105kg. Body weight is measured at the beginning and at the end of the test with an accuracy of 1 kg. Animals are fed ad libitum and penned individually. After slaughtering all animals are dissected and the same backfat thickness measurements (together with the skin) are taken as in the field test (shoulder: BF1ST, mid-back: BF2ST, loin: BF3ST) with an accuracy of 1mm using a measuring rod. Descriptive statistics of the field and station test data are shown in Table 1.

The statistical analysis consisted of two steps. First, the significance of the various environmental factors (fixed effects) were tested conducting least squares analysis using the GLM (General Linear Model) procedure of BMDP (Biomedical Computer Program) package (Dixon et al., 1988) leaving only significant effects in the model.

The second step included the estimation of variance and covariance components and corresponding heritabilities and genetic correlations using REML (Restricted Maximum Likelihood) under the animal model. The software used in the analysis include PEST for data coding (Groeneveld, 1990) and VCE 4 (Groeneveld, 1998) for parameter estimation.

The heritability estimates of BF1FT, BF2FT, BF3FT, BF1ST, BF2ST, BF3ST were obtained by using the following linear model:

$$y = Xb + Za + e$$

where:

y = vector of observations, b = vector of fixed effects, a = vector of random animal effects, e = vector of random residual effects, X and Z are incidence matrices relating records to fixed and random animal effects, respectively.

Expected values of a and e were $E(a) = E(e) = 0$. The variance-covariance structure assumed to be $V(a) = A\sigma^2_a$, $V(e) = I\sigma^2_e$, and $cov(a,e) = Cov(e,a) = 0$, where A is the numerator relationship matrix. Also $cov(y,a) = ZAI\sigma^2_a$.

In the field test the fixed effects included, herd and year-month of the test effects. The effect of the weight of the animals was also taken into account by defining it as a covariate. In the station test traits fixed effects were herd and year-month of the test and station. Sex was considered as a fixed effect both in field and station tests when it was applicable. Structure of the field and station test data can be seen in Table 2.

A three trait model was applied for both the field (BF1FT, BF2FT, BF3FT) and station (BF1ST, BF2ST, BF3ST) tests. Bivariate models were used in order to estimate the genetic correlation between BF1FT-BF1ST, BF2FT-BF2ST, BF3FT-BF3ST. The distribution

Table 1. Descriptive statistics for the examined traits

Traits	Type of test	Sex	No. records	Mean	St. dev
BF1FT(1) (mm)	field	females	62751	26.30	2.95
		males	4671	25.31	3.08
BF2FT (2) (mm)	field	females	62751	14.33	1.91
		males	4671	13.31	2.15
BF3FT (3) (mm)	field	females	62751	15.36	2.22
		males	4671	15.11	2.18
BF1ST (4) (mm)	station	females	3438	33.44	56.99
		castrates	3417	36.35	6.10
BF2ST (5) (mm)	station	females	3438	17.61	3.93
		castrates	3417	20.15	4.24
BF3ST (6) (mm)	station	females	3438	17.34	4.68
		castrates	3417	20.27	4.83

Backfat shoulder measured at the field test(1), Backfat mid-back measured at the field test(2), Backfat loin measured at the field test(3), Backfat shoulder measured at the station test(4), Backfat mid-back measured at the station test(5), Backfat loin measured at the station test(6)

Table 2. Structure of field and station test data

Traits	Sex	Herd	Year-month	Station	Tot. pedigree
BF1FT(1) (mm)	females	68	57	-	84399
	males	57	48	-	84399
BF2FT (2) (mm)	females	68	57	-	84399
	males	57	48	-	84399
BF3FT (3) (mm)	females	68	57	-	84399
	males	57	48	-	84399
BF1ST (4) (mm)	females	57	59	7	84399
	castrates	57	59	7	84399
BF2ST (5) (mm)	females	57	59	7	84399
	castrates	57	59	7	84399
BF3ST (6) (mm)	females	57	59	7	84399
	castrates	57	59	7	84399

Backfat shoulder measured at the field test(1), Backfat mid-back measured at the field test(2), Backfat loin measured at the field test(3), Backfat shoulder measured at the station test(4), Backfat mid-back measured at the station test(5), Backfat loin measured at the station test(6)

of traits was assumed to be normal. Genetic correlations were estimated among BF1FT, BF2FT, BF3FT separately on gilts and boars; among BF1ST, BF2ST, BF3ST separately on gilts and castrates; and between BF1FT-BF1ST, BF2FT-BF2ST, BF3FT-BF3ST separately on gilts, boars-castrates, gilts-castrates, boars-gilts.

RESULTS AND DISCUSSION

Concerning the various back-fat (shoulder, mid-back, loin) traits differentiation should be made between the heritability estimates of the field and station tests. Compared to the station test results field test results showed generally lower heritabilities (Table 3.) regardless of the sexe. As argued by Tran et al. (1993) the results of the ultrasonic scanning can be severally biased which can easily be the reason of the lower heritability estimates. They argued that especially in case of the back-fat measured at shoulder region the possibility of taking biased measurements can be as high as 40%. Csató et al. (1990) tested the reliability of the ultrasonic back-fat measurements by scanning live animals then slaughtering them and measuring the carcasses of the same animals on the same body regions. The correlations among the measurements were only moderately high or low (0.10-0.56) which involves the possibility of an imprecise ultrasonic scanning. Merks (1988) using the ultrasound equipment only on gilts also found relatively low heritability for backfat depth (0.28) which is also in line with the results presented here.

Station test heritability estimates were somewhat higher than that of the field test's (Table 3.). Using Hungarian Large White and Duroc breeds Váradi et al. (1997) analysed the data of various station test conducted at Keszthely, Hungary. The heritabilities were higher tan than those estimated in the present study (0.50-56 for shoulder, 0.47-0.55 mid-back and 0.72-0.78 for loin). Merks (1987) estimated moderately high heritability for backfat depth of gilts (0.57) but low heritability was reported for boars (0.29).

Table 3. Heritability, standard errors (in brackets) estimates of the field and station test traits.

Traits	Females	Males	Castrates
BF1FT (1)	0.37 (0.01)	0.36 (0.02)	-
BF2FT (2)	0.27 (0.01)	0.38 (0.02)	-
BF3FT (3)	0.37 (0.01)	0.28 (0.02)	-
BF1ST (4)	0.36 (0.02)	-	0.32 (0.02)
BF2ST (5)	0.36 (0.03)	-	0.35 (0.02)
BF3ST (6)	0.43 (0.02)	-	0.52 (0.02)

Backfat shoulder measured at the field test(1), Backfat mid-back measured at the field test(2), Backfat loin measured at the field test(3), Backfat shoulder measured at the station test(4), Backfat mid-back measured at the station test(5), Backfat loin measured at the station test(6)

Table 4. Genetic correlation and standard errors (in brackets) estimates of the field test traits.

BF1FT (1)-BF2FT (2)	BF1FT (1)-BF3FT (3)	BF2FT (2)-BF3FT (3)	Sex
0.67 (0.01)	0.24 (0.02)	0.50 (0.01)	females
0.44 (0.04)	0.63 (0.04)	0.44 (0.03)	males

Backfat shoulder measured at the field test(1), Backfat mid-back measured at the field test(2), Backfat loin measured at the field test(3)

However it has to be mentioned that the latter value was estimated on live animals with ultrasound. In general this study results justify the well known fact that station tests are more reliable than field tests.

Regarding the estimated genetic correlation coefficients among the field test traits (Table 4.), the genetic correlation among the various fat depth estimates were generally positive. The genetic correlation estimates among field traits were low to moderately high but no systematic differences were found between the estimates of the different sexes.

Estimated genetic correlations among the three back-fat measurements of the station tests exceeded those of the field test's. The pattern of the results were the same in both sexes.

Concerning the backfat depth measured at the same body regions (shoulder, mid-back, loin) in field and station tests one can consider the BFFT-BFST pairs as identical traits if genetic correlation among them is close to unity. In fact it was pointed out by Merks (1986) that backfat thickness measured in on-farm test with ultrasound and carcass backfat thickness measured in central test are not the same traits therefore genetic correlation between them is not expected to be unity but an expectation of 0.6-0.8 is more appropriate. It can be seen (Table 6.) that in the present study they were even lower than that (0.09-0.40) indicating genotype environment interaction. Merks (1989) compared the field and station tests for back-fat. When ultrasonic measurements were taken both in the station and field test and also the sex of the animals were identical the genetic correlation between BFFT-BFST was moderately high (0.7). On the other hand if the sex was male in the station test and female in the field test or vice versa then the received genetic correlations were lower (0.50-0.66) which indicates that environment together with sex effect caused more reasonable genotype environment interactions than test environment alone. Finally, if in the station test back-fat measurements were taken on carcasses rather than on live pigs using ultrasonic scanning then the genetic correlations were lowered even further (0.29-0.75). Similarly Roberts and Curran (1981) reported that genetic correlations between backfat measurements in station and field tests were higher when estimated on the same sex (0.46) compared to the estimates of different sexes (0.35). Measuring backfat thickness on boars at the station test and on gilts on the field test Bampton et al. (1977) also reported a low genetic correlation (0.34). Those results indicate genotype environment interaction. Moreover sex environment interaction was also reported by Merks (1989) and Roberts and Curran (1981).

The genetic correlation estimates across sexes (table 6) were not necessary lower than those of the same sex which means that the existence of the sex environment interaction was not observed. The last result is somehow surprising but as noted by Meuwissen and Kanis (1988) the chance of inconsistent parameter set is relatively high in situations with genotype environment interactions. Nevertheless, it is clear that carcass backfat thickness measured as ultrasonicly on live pigs and on carcasses are not the same traits and correlations is not equal to one, therefore ranking of boars based on the two environments might differ.

CONCLUSION

From table 6. it can be suggested that every effort should be made in order to lessen the back fat field test measurements residual variances caused by the operators of the ultrasonic equipments by increasing the measuring discipline and care. Moreover enlarging

Table 5. Genetic correlation and standard errors (brackets) estimates of the station test traits.

BF1ST (1)-BF2ST (2)	BF1ST (1)-BF3ST (3)	BF2ST (2)-BF3ST (3)	Sex
0.76 (0.04)	0.75 (0.04)	0.88 (0.02)	females
0.79 (0.04)	0.75 (0.04)	0.80 (0.02)	castrates

Backfat shoulder measured at the station test(1), Backfat mid-back measured at the station test(2), Backfat loin measured at the station test(3)

Table 6. Genetic correlation and standard errors (in brackets) estimates among the field and station test traits (measured at the same regions).

BF1FT (1)-BF1ST (4)	BF2FT (2)-BF2ST (5)	BF3FT (3)-BF3ST (6)	Sex
0.24 (0.05)	0.37 (0.05)	0.09 (0.04)	females-females
0.25 (0.05)	0.12 (0.04)	0.28 (0.05)	males-castrates
0.26 (0.05)	0.28 (0.05)	0.16 (0.04)	females-castrates
0.10 (0.05)	0.18 (0.05)	0.40 (0.05)	males-females

Backfat shoulder measured at the field test(1), Backfat mid-back measured at the field test(2), Backfat loin measured at the field test(3), Backfat shoulder measured at the station test(4), Backfat mid-back measured at the station test(5), Backfat loin measured at the station test(6)

the applied linear models with the operators' code the residual variance may be controlled and their performance may be monitored as done in the Netherlands (Knap, 1993).

At the same time it might be worth considering that increasing the similarity between the station and field tests by using the same grouping system (small groups) in both environments, applying transponders and automatised feeding systems in the station test the genetic correlations should probably be higher than those of received here. Thus the ranking of boars based on the different testing methods would definitely be more close to each other as in the present situation. As the breeding goal in Hungary has been defined for both at the nucleus and multiplication level the national breeding programme has to use the results of the field test along with the results of the central test. An-other possibility would be to define the breeding goal at the level of commercial fattening as suggested by Brascamp et al. (1985) and in that case abattoir data could serve selection more effectively. However a difficulty is that there is still an unsolved identification problem preventing the use of this source of information in the selection procedure.

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